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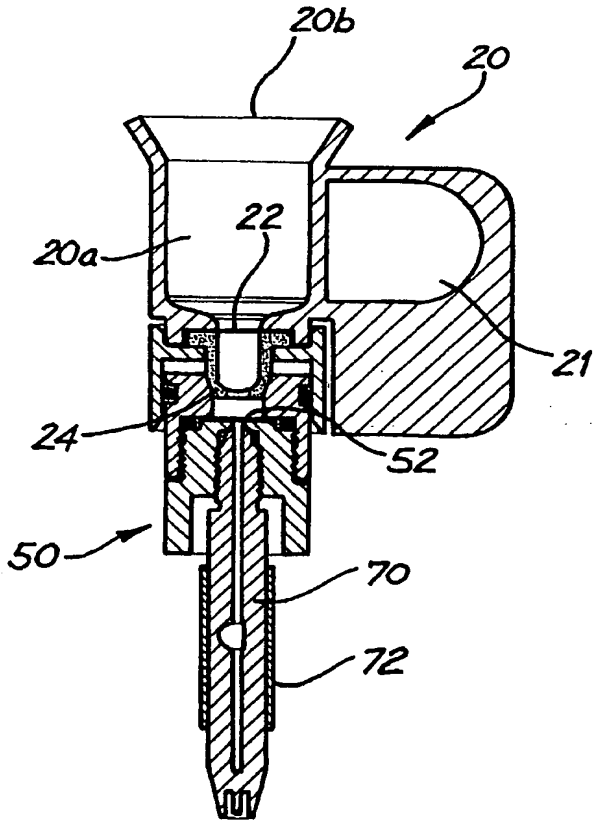
[Continued on next page]

(54) Title: APPARATUS FOR DISPENSING AND PRINTING FLUIDS



(57) Abstract: A piezoelectric dispensing apparatus (10) includes a piezoelectric dispensing device (20) including a fluid reservoir (20a) and a piezoelectric dispensing tube (70). The apparatus includes a seat for receiving the device and a plunger which is shaped and configured to abut with and seal the top of the reservoir and which defines a through bore to permit the application of vacuum and or pressure to the reservoir through the bore. The plunger may be moved up and down towards and away from the seat. The fluid reservoir defines an open top and an outlet at the base of the reservoir closed by a filter. The base of the reservoir define a foot. A secondary filter assembly is attachable to the base of the reservoir. The secondary filter assembly defines a bore which is in fluid communication with the reservoir when the secondary filter assembly is attached thereto, The secondary filter assembly also defines means for removably attaching the piezoelectric dispensing tube in fluid communication with the bore. The device includes a ducks bum valve or septum for closing the outlet of the reservoir until the reservoir is attached to the removable secondary filter assembly.

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Published:

— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

"Apparatus for dispensing and printing fluids"

Field of the Invention

This invention relates to an apparatus for printing and dispensing fluids. In particular, the invention relates to the piezoelectric device for accurately dispensing small volumes of liquids into a container or onto a surface.

Background of the Invention

In the fields of chemistry and biological sciences, piezoelectric devices are commonly used to accurately dispense small quantities of liquids into a container or onto a surface. Present applications include dispensing reagents onto protein arrays for protein analysis, chemical printing for peptide mass finger printing, and oligonucleotide array printing. Existing piezoelectric devices can control dispensing with an accuracy of +/- 100 picolitres. A typical piezoelectric device comprises a glass tube which defines a narrow through bore or capillary. The glass tube is surrounded by a ceramic collar which expands and contracts under the influence of a changing electric potential applied to the collar which causes a sonic wave in the bore. In use, a vacuum/pressure source is applied to one (non-dispensing) end of the bore. Using the well known "dip and suck" process, the dispensing end of the tube is dipped in a liquid reagent to be dispensed. A vacuum/reduced pressure is applied to suck the liquid reagent into the bore. The pressure /vacuum in the device is adjusted to retain the reagent in the tube and ensure that the meniscus at the dispensing end of the bore is flat. A changing electric potential is then applied to precisely dispense one or more drops of reagent from the dispensing end of the tube, as desired.

There are a number of problems with existing piezoelectric dispensing devices. One problem is the presence of particulate matter in the fluid being dispensed, which may block the bore of the piezoelectric device.

A further problem is that when dispensing some liquids, a slight pressure must be applied to the solution in order to produce a droplet at the orifice of the device.

Further, when dispensing liquids having a high viscosity or high visco-elasticity, the use of pressure and/or vacuum may be required.

An aim of the present invention is to address and alleviate any problems of the prior art discussed above.

Any discussion of documents, acts, materials, devices, articles or the like which has been included in the present specification is solely for the purpose of providing a context for the present invention. It is not to be taken as an admission that any or all of

these matters form part of the prior art base or were common general knowledge in the field relevant to the present invention as it existed before the priority date of each claim of this application.

Throughout this specification the word "comprise", or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated element, integer or step, or group of elements, integers or steps, but not the exclusion of any other element, integer or step, or group of elements, integers or steps.

Summary of the Invention

In a first broad aspect, the present invention provides a piezoelectric dispensing apparatus including:

a removable reservoir for containing liquid for dispensing from the apparatus;

a piezoelectric dispensing tube defining a bore in fluid communication with the reservoir; and

means for applying a vacuum and/or pressure to the contents of the reservoir when the reservoir is located in the apparatus.

One advantage of the present invention is that reagent can simply be loaded into the apparatus in the reservoir eliminating the existing and time consuming and occasionally messy "dip and sip" technique.

Typically the top of the reservoir will be open to allow liquids to be poured into the reservoir. Most preferably the top of the reservoir will be outwardly flared. The means for applying a vacuum and/or pressure to the contents of the reservoir when the reservoir is located in the apparatus will include a plunger which is shaped and configured to abut with and seal the top of the reservoir. The plunger preferably defines a through bore to permit the application vacuum and or pressure to the reagent vessel through the bore.

In a second broad aspect, the present invention provides a reagent vessel for use with a piezoelectric device which provides filtering within the vessel.

In particular, there is provided a reservoir assembly for containing liquid for dispensing from a piezoelectric dispensing apparatus characterised by the assembly including a primary and a secondary filter means.

The primary filter takes out most of the particles in solution. The secondary filter preferably has a pore size smaller than the primary filter and removes any particulate matter not removed by the primary filter and particulate material below the primary filter. Where the reservoir is removable from the vessel and also from the piezoelectric dispensing tube the secondary filter may be located between the reservoir

and the non-dispensing end of the piezoelectric dispensing tube to prevent particulate matter collected on the underside of the reservoir from entering the tube.

In a further aspect of the present invention there is provided a piezoelectric dispensing apparatus including:

a reservoir for containing liquid for dispensing from the apparatus defining an outlet;

a piezoelectric dispensing tube defining a bore;

means for removable attaching the piezoelectric dispensing tube in fluid communication with the reservoir; characterised by

closure means such as a valve or septum disposed at the base of the reservoir which closes the outlet of the reservoir until the reservoir is attached to a removable secondary filter attached to a piezoelectric dispensing tube.

Preferably the base of the reservoir defines an annular foot portion on which the reservoir may be rested with the valve spaced from the surface on which the foot rests.

Brief Description of the Drawings

A specific embodiment of the invention will now be described by way of example only, and with reference to the accompanying drawings in which:

Figure 1a is a schematic front view of a dispensing apparatus embodying the present invention;

Figure 1b is a schematic side view of the dispensing apparatus of Figure 1;

Figure 2a is a schematic side view of a reagent vessel for use in the dispensing apparatus of Figure 1;

Figure 2b is a schematic front end view of a reagent vessel for use in the dispensing apparatus of Figure 1;

Figure 2c illustrates a secondary filter assembly;

Figure 3 illustrates the reservoir of Figure 2a and secondary filter assembly of Figure 2c coupled to a piezoelectric dispensing device;

Figure 4 illustrates the mechanism controlling the plunger position; and

Figure 5 shows an alternative reagent vessel.

Detailed Description of a Preferred Embodiment

Referring to the drawings, Figure 1 shows a schematic diagram of a piezoelectric dispensing apparatus 10. The apparatus defines an array of four plungers 12 below which are aligned a series of four seats configured to receive and support reagent vessels 20 located below the plungers. The apparatus also includes associated

drive mechanisms for moving the plungers vertically up and down, towards and away from the seats. Each of the plungers defines a central through bore 14 (refer to Figure 9) which can be connected to a source of vacuum and/or pressure.

A reagent vessel 20 is shown in more detail in Figures 2a and 2b. The reagent vessel is made in four parts, a combined reservoir 20a and optional integral finger grip or handle 21; a filter 22; a closure means in the form of a one way PVP valve of the type colloquially known as a "ducks bum valve" 24, but which in other embodiments may be replaced by a septum or other closure means) and an annular foot portion 26 which is circular in plan view. The reservoir 20a and integral finger grip and the foot portion 26 are made of a plastics material and the parts re ultrasonically welded together capturing the valve 24 and filter 22 therebetween.

The reservoir 20a is generally rotationally symmetrical having a flared upper end 28 so that it resembles an upturned bell. The upper end 20b of the reservoir is open so that liquids may be poured directly into the reservoir.

The lower end 30 of the reservoir is closed by the valve 24. The valve comprises a rubber cup which depends from a flanged rim 24a. An elongate slit 24b which is normally closed as shown in Figures 2a and 2b, is defined in the lower part of the cup, but which when the sides of the valve adjacent each end of the slit are squeezed, the valve opens up for as long as that squeezing pressure is maintained. The optional finger grip 30 facilitates handling of the reagent vessel and loading of the vessel into the apparatus.

The foot portion 26 located below the reservoir, has an annular cross section, the base of which defines a circular base or foot 32. The foot portion also defines a internal flange 34 which supports the flanged rim 24a of the valve 24. The filter 22 is located above the valve 24 to capture particulates from solutions contained in the reservoir and prevent them from passing into a piezoelectric dispensing device, which in use, is located below the reservoir.

The foot portion 32 serves two functions. It allows the reagent vessel to be placed on a laboratory bench and prevents the valve 24 from touching the bench surface and opening. It also acts a sealing surface between the reagent vessel and a secondary filter holder shown in Figure 2e.

Two rupture lines (of which one 40 is shown in Figure 2a) may optionally be defined in the upper part of the walls of the reservoir. When the reagent vessel is removed from the apparatus 10, the rupture lines may be ruptured which would prevent the reagent vessel from being reused.

Also shown in Figure 2b are optional bayonet guides 42 which are used to locate the reagent vessel in the apparatus 10.

The secondary filter holder 50 is shown in Figures 2c comprises two threaded metal parts 50a, 50b that are screwed together with a secondary filter 52 clamped between the two sections. The secondary filter captures any particulates located below the primary filter 22. An O ring 54 extends around the outside of the upper end of the secondary filter assembly. In use when the secondary filter holder is inserted into the foot portion 26 of the reagent vessel the O ring provides a fluid tight seal.

A generally cylindrical outwardly flared aperture 56 is defined in the top surface of the secondary filter assembly. This aperture 56 is sufficiently shallow, and the size and shape of the aperture are such that when the secondary filter assembly is attached to the reagent vessel 20, the base of the valve 24 in the reagent vessel will push against the hole and open.

The lower part of the secondary filter assembly defines a bore in fluid communication with the aperture 56. The bore has a first diameter and a second relatively narrower diameter 58 which is threaded. A piezoelectric dispensing tube may be threaded into the narrow diameter bore 58. A standard piezoelectric dispensing tube 70 comprising a glass tube which defines a narrow through bore or capillary surrounded by a ceramic PZT material collar 72 which expands and contracts under the influence of a changing electric potential applied to the collar is used. The tube 70 secondary filter holder 50 and reagent vessel 20 are assembled together as shown in Figure 3a. Liquid for dispensing is put in the reservoir/reagent vessel through the open upper end of the reservoir. If the reagent vessel contains liquid at the time the three components are assembled, the secondary filter should be attached to the tube 70 before being attached to the reagent vessel otherwise the valve 24 will open and leak.

Figure 3 shows a piezoelectric device is screwed into the threaded bore of the secondary filter assembly which in turn, is attached to the reservoir 20.

With reference to Figure 1a, the assembled reagent vessel, secondary filter assembly and piezoelectric device, are placed in a seat 60 in the dispensing apparatus 10, with the finger grip oriented to the right. The reservoir is loaded with reagent to be dispensed prior to loading in the apparatus. The bayonet guides 42 locate in grooves in the apparatus and the finger grip is then rotated in a clockwise direction to the left so that it extends to the front of the apparatus as shown in Figure 1b, and the bayonet guides rotate along grooves in the reception means which slope towards the base of the dispensing apparatus and as well as guiding the assembly, push the assembly down.

The plunger is then lowered and the head of the plunger locates in the flared portion of the reservoir. An O ring extending around the plunger head, provides a seal and locks the reagent vessel into the dispensing apparatus.

As illustrated in Figure 1a, the apparatus has the capacity to receive four reagent vessels.

As shown in Figure 5, each plunger defines a central through bore 14. The bore is linked to a means for applying a vacuum, or pressure through the bore to the reservoir 20 of the reagent vessel. The piezoelectric devices are primed by applying pressure to the liquid in the reagent vessel through the bore of the plunger which pushes the liquid through the primary filter 22 and through the secondary filter 52. Piezoelectric electric devices are operated for droplet dispensing under low vacuum conditions to control the fluid meniscus at the orifice of the piezoelectric device. A pneumatics control shown schematically at 50 corrects imbalances in surface tension of the fluid, capillary action or hydrostatic pressure that prevents solution from being dispensed from the piezoelectric device. Droplets are dispensed from the piezoelectric device by applying an electric pulse or wave to the device which generate an acoustic wave in the solution in the glass capillary resulting in a droplet being dispensed from the device orifice. These techniques are well known in the field of glass capillary piezoelectric dispensing.

On completion of dispensing, the reagent vessel may be released from the apparatus by means of a small downward motion of the plunger initiated by the pressing of a release button. The additional pressure on the flared portion causes the breaking of the rupture lines 40 preventing re-use of the reagent vessel. The plunger then rises as shown in Figure 8 and returns to the top of the apparatus. The used reagent vessel can be removed and discarded. Once the reagent vessel is released from the apparatus, the valve at the bottom of the reagent vessel, will close preventing any unused solution from leaking out of the reagent vessel.

Alternatively, the plunger may simply rise, leaving the vessel intact.

The operation of the plunger is illustrated in more detail in Figure 9. At rest, the plunger position is controlled by an indexing cam mechanism which comprises a star shape control element and a smaller index element. The index element is acted on a sprung detent which is shaped to give the cam a tendency to return to the indexed position. The cam and detent mechanism are mounted on a pivoting arm which is held in a default position by a spring.

The plunger is also held in its rest position by a spring. When the plunger is depressed, a drive pin attached to it travels downwards and engaging a lobe of the cam

causes it to turn. As the plunger is further depressed, the cam turns sufficiently to allow the detent to engage the next index position. At this point, the cam ceases to be driven by the plunger, rather it is the force applied by the detent mechanism that causes it to continue turning. This rotation means that the next lobe of the cam to bear on the drive pin and depress the plunger further. This action is sufficient to complete the loading of the reaction vessel and is arranged so that with the vessel in place, some force is still exerted by the detent on the cam. This ensure that the cam is able to apply sufficient pressure to the plunger to maintain a seal with the reagent vessel. This condition is maintained until the release mechanism is actuated. The release lever acts on the pivoting arm depressing it causing the cam and arm assembly to slide aside releasing the drive pin and allowing the plunger to return to its rest position. The pivoting of the arm is arranged so that on route to release the plunger, is forced further downwards providing the extra travel required to rupture the vessel.

Figure 10 illustrates a second embodiment of a reagent vessel 110 including an open topped reservoir 120 similar to reservoir 20 of the first reagent vessel. However in the reagent vessel 110 the closure means closing the base of the reservoir is a septum 121 disposed below the filter 122 rather than a valve. There is no integral finger grip.

The secondary filter holder 150, is similar to the filter holder 50 of the first embodiment. It comprises two threaded metal parts 150a, 150b that are screwed together with a secondary filter 152 clamped between the two sections. The secondary filter captures any particulates located below the primary filter 22. Part 150a to which the piezoelectric tube is attached is identical to part 50a. Part 150b defines two differences from part 50b. There is no external O-ring 54 and the secondary filter holder 150b defines an upwardly protruding hollow needle 151, of a length which pierces the septum 121 when the secondary filter assembly is screwed to the base of the reservoir, but does not reach or pierce the filter 122. This obviates the need to have a valve at the base of the reservoir and reduces manufacturing costs. The hollow needle is in fluid communication with a chamber 156.

The lower part 150a of the secondary filter assembly 150 defines a bore 158 in fluid communication with the chamber 156 via the secondary filter 152. The bore 158 has a first diameter and a second relatively narrower diameter 158 which is threaded. A piezoelectric dispensing tube may be threaded into the narrow diameter bore 58. A standard piezoelectric dispensing tube 70 as shown in Figure 3a can be used. The tube 70 secondary filter holder 150 and reagent vessel 110 are assembled together in the same way as the first embodiment shown in Figure 3a. Liquid for dispensing is put in the reservoir/reagent vessel 120 through the open upper end of the reservoir. If the

reagent vessel contains liquid at the time the three components are assembled, the secondary filter holder 150 should be attached to the tube 70 before being attached to the reagent vessel otherwise the valve 24 will open and leak.

With reference to Figure 1a, the assembled reagent vessel, secondary filter assembly and piezoelectric device, are placed in a seat 60 in the dispensing apparatus 10 and the device is used in the same way as the first embodiment, as described above.

There may be an array of greater or fewer than four piezoelectric dispensing devices in the apparatus. The use of micro-arrayed solid state piezoelectric ceramic may permit closely arrayed multiple channels and up to possibly one hundred solution streams.

It will be appreciated by persons skilled in the art that numerous variations and/or modifications may be made to the invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive.

CLAIMS:

1. A piezoelectric dispensing apparatus including:

a removable reservoir for containing liquid for dispensing from the apparatus;

a piezoelectric dispensing tube defining a bore in fluid communication with the reservoir; and

means for applying a vacuum and/or pressure to the contents of the reservoir when the reservoir is located in the apparatus.

2. A piezoelectric dispensing apparatus as claimed in claim 1 wherein the reservoir defines an open top to allow liquids to be poured into the reservoir.

3. A piezoelectric dispensing apparatus as claimed in claim 2 wherein the top of the reservoir is flared outwardly.

4. A piezoelectric dispensing apparatus as claimed in claim 3 wherein the means for applying a vacuum and/or pressure to the contents of the reservoir when the reservoir is located in the apparatus includes a plunger which is shaped and configured to abut with and seal the top of the reservoir.

5. A piezoelectric dispensing apparatus as claimed in claim 4 wherein the plunger defines a through bore to permit the application of vacuum and or pressure to the reagent vessel through the bore.

6. A piezoelectric dispensing apparatus as claimed in any one of claims 4 to 5 including a seat for receiving the removable reservoir and means for moving the plunger up and down towards and away from the seat.

7. A reservoir assembly for containing liquid for dispensing from a piezoelectric dispensing device, the piezoelectric dispensing device including a dispensing end and a non-dispensing end, characterised by the assembly including a first and a second filter means.

8. A reservoir assembly as claimed in claim 7 wherein the second filter has a pore size smaller than the pore size of the first filter

9. A reservoir assembly as claimed in claim 7 or claim 8 wherein the second filter is located between the reservoir and the non-dispensing end of the piezoelectric dispensing tube to prevent particulate matter collected on the underside of the reservoir from entering the tube.

10. A piezoelectric dispensing device including:

a reservoir for containing liquid for dispensing from the apparatus defining an open top and an outlet at the base of the reservoir;

a filter means for filtering liquids passing through the outlet;

a piezoelectric dispensing tube defining a bore;

means for removably attaching the piezoelectric dispensing tube in fluid communication with the reservoir; characterised by

a closure means disposed at the base of the reservoir which closes the outlet of the reservoir until the reservoir is attached to a removable secondary filter attached to a piezoelectric dispensing tube.

11. A piezoelectric dispensing device as claimed in claim 10 wherein the base of the reservoir defines an annular foot portion on which the reservoir may be rested with the valve spaced from the surface on which the foot rests.

12. A piezoelectric dispensing device as claimed in claim 11 wherein the reservoir defines a handle.

13. A piezoelectric dispensing device as claimed in any one of claims 10 to 12 wherein the closure means is a septum.

14. A piezoelectric dispensing device as claimed in any one of claims 10 to 12 wherein the closure means is a valve.

15. A piezoelectric dispensing device including:

a reservoir for containing liquid for dispensing from the device defining an open top and an outlet at the base of the reservoir;

a filter extending across the outlet of the reservoir;

a secondary filter assembly attachable to the base of the reservoir, the secondary filter assembly defining a bore which is in fluid communication with the reservoir when the secondary filter assembly is attached thereto, the secondary filter assembly defining means for removably attaching the piezoelectric dispensing tube in fluid communication with the bore; characterised by

means for closing the outlet of the reservoir until the reservoir is attached to the removable secondary filter assembly.

16. A piezoelectric dispensing device as claimed in claim 15 further including a piezoelectric dispensing tube defining a bore attached to the outlet of the secondary filter assembly.

17. A piezoelectric dispensing device as claimed in claim 15 or 14 wherein the means for closing the outlet of the reservoir is a valve.

18. A piezoelectric dispensing device as claimed in claim 12 or 16 wherein the means for closing the outlet of the reservoir are a septum and wherein a hollow needle for piercing the septum projects from the secondary filter assembly.

19. A piezoelectric dispensing apparatus including a piezoelectric dispensing device as claimed in any one of claims 10 to 19 further including a seat means for receiving the removable reservoir in the apparatus means for applying a vacuum and/or pressure

to the contents of the reservoir when the reservoir is located in the apparatus said means including a plunger which is shaped and configured to abut with and seal the top of the reservoir and which defines a through bore to permit the application of vacuum and or pressure to the reagent vessel through the bore and further including and means for moving the plunger up and down towards and away from the seat.

20. A method of dispensing fluid from a piezoelectric tube assembly including a piezoelectric tube having a dispensing end and a non dispensing end comprising dispensing the fluid from a reservoir disposed in fluid communication with the non-dispensing end of the piezoelectric tube.

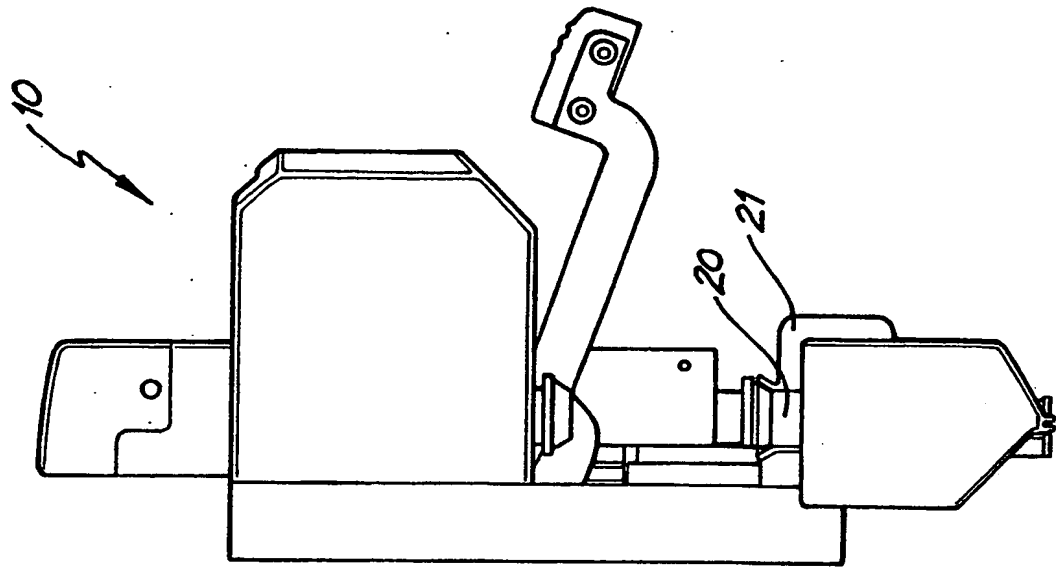

FIG. 1b

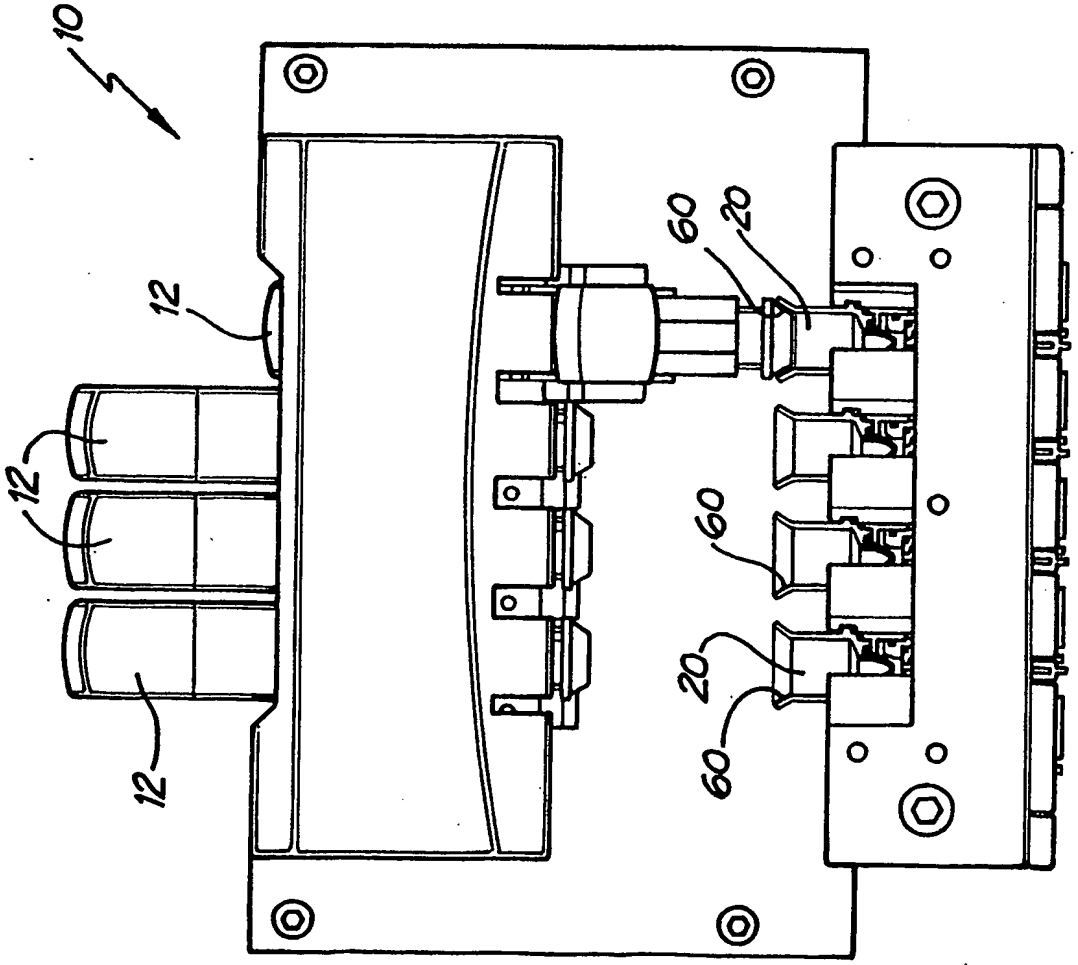

FIG. 1a

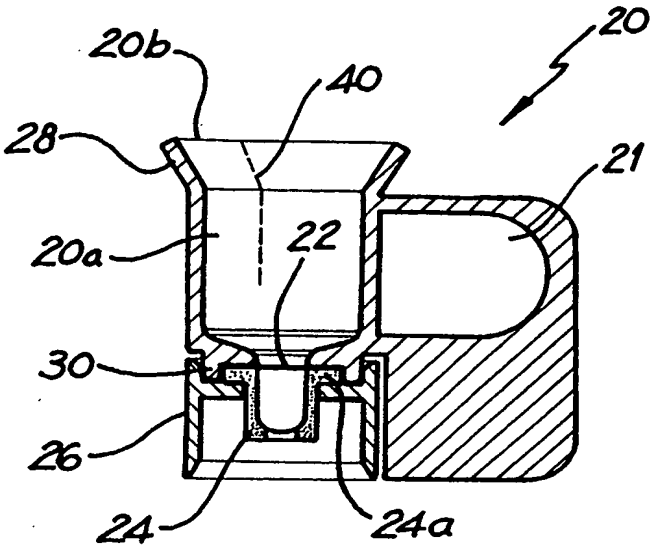

FIG. 2a

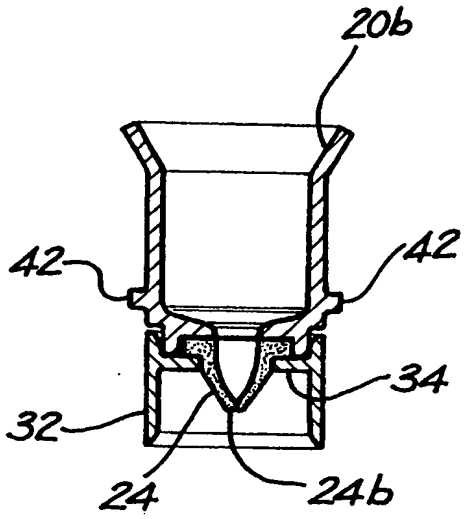

FIG. 2b

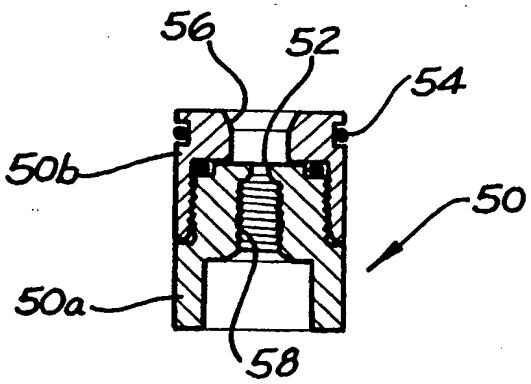

FIG. 2c

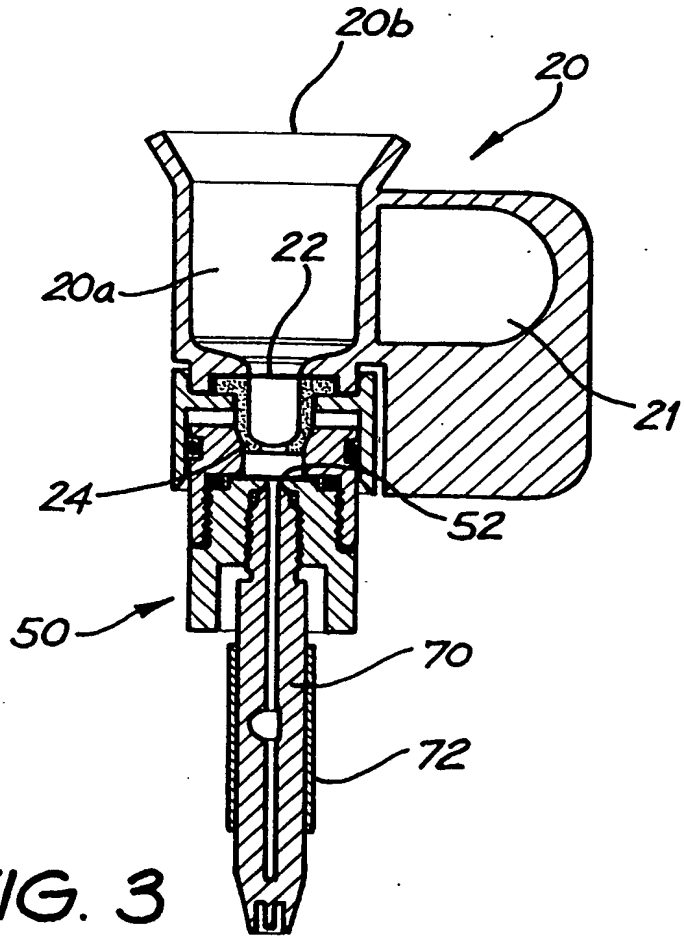

FIG. 3

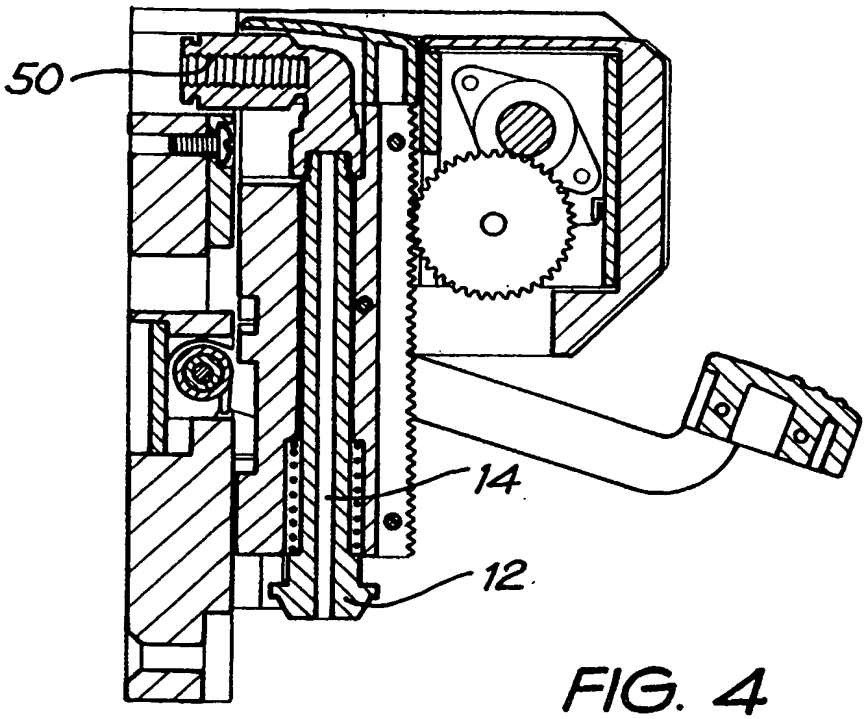

FIG. 4

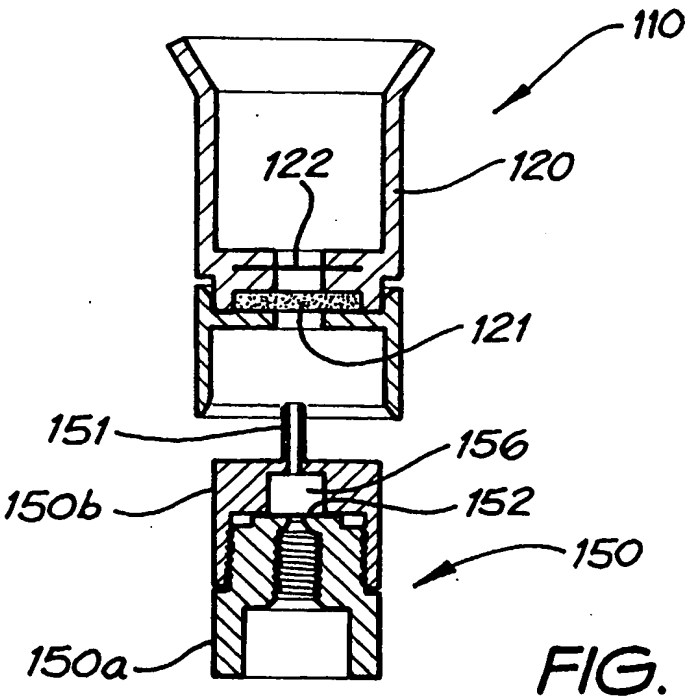

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2004/000393

Supplemental Box
(To be used when the space in any of Boxes I to VIII is not sufficient)

Continuation of Box III:

The international application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept. In coming to this conclusion the International Searching Authority has found that there are different inventions as follows:

1. Claims 1-6 are directed towards a piezoelectric dispensing device which has a removable reservoir for containing liquid, a piezoelectric tube in communication with the reservoir and means which applies a vacuum or pressure to the liquid in the reservoir. It is considered that the means to supply a vacuum or pressure to the liquid in the reservoir comprises a first "special technical feature".

2. Claims 7-19 are directed to a piezoelectric dispensing device which has a reservoir for containing liquid, and a piezoelectric tube in communication with the reservoir. The reservoir includes first a second filter means. It is considered that the reservoir having first and second filter means comprises a second "special technical feature".

3. Claim 20 is directed to a method of dispensing fluid from a piezoelectric tube assembly, which has a dispensing end and a non-dispensing end. The method comprises dispensing fluid from a reservoir which is connected to the non-dispensing end of tube. It is considered that the step of dispensing fluid from a reservoir which is connected to the non-dispensing end of tube comprises a third "special technical feature".

The feature common to all of the claims is a reservoir connected to a piezoelectric tube. However this common feature is generic in the printing and dispensing arts. Consequently the common feature does not constitute "a special technical feature" within the meaning of PCT Rule 13.2, second sentence, since it makes no contribution over the prior art. Since there exists no other common feature which can be considered as a special technical feature within the meaning of PCT Rule 13.2, second sentence, no technical relationship within the meaning of PCT Rule 13 between the different inventions can be seen. Consequently the claims do not satisfy the requirement of unity of invention a posteriori.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2004/000393

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See separate sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☒ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2004/000393

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. [7]: G01N 35/10, B41J 2/175

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
DWPI, JAPIO: B67D, B41J, piezo, reservoir, tank, dispense, eject, vacuum, plunger, piston, filter and similar terms

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2000/005073 A (3WG INCORPORATED) 3 February 2000 Page 1 lines 17-20, page 8 lines 3-14, page 8 line 24-page 9 line 3, figures	1-3, 7-9, 20
X	US 5552816 A (ODA et al) 3 September 1996 Col 1 lines 55-59, col 5 lines 29-32, col 9 line 55-col 10 line 6, figures 1-3	1-3, 7-18, 20
X	US 5907341 A (MIYAZAWA) 25 May 1999 Abstract, column 3 lines 13-65, figures	1-3, 7-9, 20
X	US 6511157 B1 (YOSHIMURA et al) 28 January 2003 Column 1 line 34-column 2 line 39, column 4 line 49-column 5 line 38	1-3, 7-9, 20

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 May 2004	- 7 JUN 2004
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized officer **GREG POWELL** Telephone No : (02) 6283 2308

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2004/000393

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5680164 A (MILLER et al) 21 October 1997 Figures 2-10	7-18, 20
X	JP 2000-329771 A (OLYMPUS OPTICAL CO LTD) 30 November 2000 Abstract, figures	20
P, X	NL 1019359 C (MACHINEFABRIEK ROERSTREEK B.V.) 14 May 2003 Abstract, figures	20

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/AU2004/000393

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
WO	2000/005073	AU	52260/99				
US	5552816	JP	5-330076				
US	5907341	EP	665108	EP	914956	HK	1020550
		JP	7-125238	SG	52541	US	5633667
		US	6280024				
US	6511157	DE	19708016	JP	9-239974		
US	5680164	DE	19512812	GB	2295583	HK	1011949
JP	2000-329771	NONE					
NL	1019359	NONE					

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX